

REMARKS

Claims 1-4, 8-14, 18-20, 22-31 are pending in the application. Claims 5-7, 15-17, and 21 were previously cancelled. Claims 1, 11, 13, and 19 have been amended. No new matter has been added and the amendments are fully supported and justified by the specification. Support for the amendments appears in Applicant's specification at, for example, p. 11 lines 5-21.

Claims 1-4, 8-14, 18-20, 22-31 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Umberger et al. (U.S. Patent 6,957,433), in view of Hinshaw et al. (U.S. Application 2004/012842), and in further view of Hartman et al. (The Zebra Striped Network File System). The rejection is respectfully traversed.¹

Applicant's claims are directed to systems and methods for providing differentiated classes of storage to clients accessing a storage system. This is accomplished by determining a level of performance for the storage locations within the system and then partitioning locations into regions as determined by their different levels of performance. In some embodiments, for example, a performance process measures the performance of storage locations by making experimental read and write operations across the logical block name space, and uses the measurements to determine whether various locations can be aggregated into regions (see, e.g., specification p. 7, lines 4-11). A mapping process maps and aggregates the logical block names of locations having an identical level of performance (i.e., the partitioned locations) to a section of the logical block name space (i.e., thereby creating different storage pools providing different classes of storage). For example, in some embodiments the system assigns different RAID levels to different regions based on the determined levels of performance of the locations within the regions (see, e.g., specification p. 2, lines 17-19 and p. 4, lines 9-11; see also FIG. 4). Clients accessing the system can utilize the storage pool with the appropriate performance level needed to carry out the desired class of service (see, e.g., specification p. 11, lines 5-8). For example, one client may utilize a RAID 10 service, and another may utilize a RAID 5 service (see, e.g., specification p. 9, line 22 to p. 10, line 2).

¹ Examiner's 103(a) rejection fails for at least two reasons. First, the references in combination do not disclose every element of the claimed invention. Second, one skilled in the art would not have any motivation to combine the cited references.

Thus, Applicant's claimed approach exposes different classes of storage to clients of the system (i.e., as reflected in the LBN), from the same storage device. The individual classes are optimized by actually determining the level of performance of storage locations, and mapping and aggregating locations having an identical level of performance to a section of the LBN (i.e., a class of storage).

Applicant respectfully submits that the Office Action reflects a characterization of Applicant's claims that is inconsistent with how one skilled in the art would understand the claimed invention. To progress the case, Applicant has amended claims 1, 11, and 19 to clarify that the claimed approach provides differentiated classes of storage to "one or more clients accessing the system." Applicant submits, however, that this amendment merely clarifies what is already stated in the claim. Providing differentiated classes of storage is stated in the preamble of the independent claims. The bodies of the independent claims recite that the regions having identical levels of performance are mapped and aggregated to a section of the logical block name space. By mapping and aggregating regions to the sections of the "logical name space," Applicant's claimed approach would be understood by one skilled in the art to be exposing, as a class of service, the different classes of storage to clients accessing the system. For example, one client may access Raid 5, while another accesses RAID 10.

The 103(a) Rejection Fails Because The Cited Combination Does Not Disclose Every Element Of The Claimed Invention

None of the cited references, nor their combination, provides different classes of client-accessible storage by mapping regions to the LBN space after actually detecting the performance levels of regions of a storage device. Umberger is aimed at solving the bottlenecking problem that occurs during processing multiple tasks or workloads in a multi-component system (see Umberger column 1, lines 58-65). Umberger discloses a load balancing technique that dynamically allocates processing power available at the system components to respond to a large number of tasks or workloads (see Umberger column 2, lines 7-17). As the Examiner appears to acknowledge, Umberger does not disclose providing differentiated classes of storage based on determining the performance of various storage locations.

Hinshaw does not cure the deficiencies of Umberger. Hinshaw attempts to solve the problem of recovery in a RAID controller failure in a system implementing RAID level 1 (see Hinshaw paragraph 2, lines 4-7 and paragraph 3, lines 5-10). The Hinshaw system discloses moving the mirrored data volume to the shorter tracks on a storage disk, while the primary data remains at the longer tracks (see Hinshaw paragraph 4, lines 10-12). Hinshaw does not determine any level of performance on the storage disk because it initially assumes, albeit incorrectly, that performance would increase by moving the mirrored data to the shorter tracks.

Hartman also does not make up for these deficiencies. Hartman discloses a method for enhancing the performance of RAID 5 within a log-based system – specifically, teaching how a system can perform full stripe writes by aggregating I/O requests (see Hartman p. 32, paragraph 1). Hartman does not disclose providing differentiated classes of storage – it provides one class. Moreover, Applicant respectfully submits that Hartman does not disclose "aggregating . . . logical block names of . . . storage locations in . . . partitioned regions having an identical level of performance." Indeed, Hartman is not aggregating storage locations. Hartman discloses aggregating I/O requests so that they may be handled sequentially, thereby enhancing the overall performance of Hartman's log-based RAID 5 system (see Hartman p. 31, last paragraph to top of p. 32). In other words, Hartman's aggregation occurs at the RAID level, whereas in the claimed approaches, different classes of storage (e.g., different types of RAID) are provided to storage pools.

The 103(a) Rejection Fails For Lack Of Motivation To Combine The References

Examiner's rejection also fails because one skilled in the art would not be motivated to combine the cited references, at least from an engineering standpoint. For example, a reasonable person skilled in the art would not combine Umberger with Hinshaw because Hinshaw's way of mirroring would negatively affect the overall system performance in Umberger. Hinshaw uses the shorter tracks for mirroring precisely because they have a lower transfer rate than the tracks Hinshaw uses for the main volume (see Hinshaw paragraph 4, lines 6-10), which Hinshaw suggests "may" enhance the overall performance of the system (see Hinshaw paragraph 4, line 12). But this is simply not the case. Hinshaw suggests that the mirror is only used during recovery (see Hinshaw paragraph 3, lines 7-10), but one skilled in the art would understand that a mirror volume is useful for enhancing the overall performance of the system. The mirror

volume can be leveraged to service read requests when the main volume is too busy. But by degrading the mirror to a lower level of service as Hinshaw does, it removes that volume as an option for servicing requests. Writes to the mirror volume may take too long to allow for reads to take place in a manner that allows a predictable level of performance to be achieved. Consequently, Hinshaw's mirror volume cannot be leveraged to enhance overall system performance. Hinshaw's approach would actually decrease the performance of the Umberger system, which is contrary to Umberger's stated goal of optimizing overall system performance. One skilled in the art simply would not make this combination and, indeed, would be motivated by Umberger's goal of enhancing overall performance *not* to make such a combination.

Additional Comments

A typographical error was also corrected in claims 1, 11 and 13, as reflected in the above amendments.

Finally, Applicant would like to bring to Examiner's attention the apparently inadvertent omission of Examiner's initials for References A7, A8, and A9 in Applicant's Supplemental IDS submitted June 16, 2006 and returned by the Examiner with the current Office Action. Applicant respectfully requests that Examiner initial these References to reflect they were in fact considered.

In view of the above amendments and remarks, Applicant believes the pending application is in condition for allowance. Reconsideration and allowance are respectfully requested.

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Amendment dated April 18, 2007
Reply to Office Action of October 20, 2006

Docket No.: EQLC-P01-005

Applicant believes no fee is due with this response other than as reflected on the attached Amendment Transmittal Letter. However, if a fee is due, please charge our Deposit Account No. 18-1945, under Order No. EQLC-P01-005 from which the undersigned is authorized to draw.

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